09/220 849

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

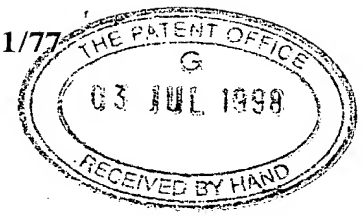
Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 31 May 2006

CERTIFIED COPY OF
PRIORITY DOCUMENT
Best Available Copy

Patents Form 1/77



The **Patent Office**

Patents Act 1977
(Rule 16)

06JUL98 E373391-1 D00032
P01/7700 25.00 - 9814513.9

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — PJF

2. Patent application number *(The Patent Office will fill in this part)* — Filed Herewith
03 JUL 1998
9814513.9

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Peter Craven
6 Kings Road
Lancing
West Sussex
BN15 8EA
United Kingdom 7470156001

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention

TRANCODERS FOR FIXED AND VARIABLE RATE DATASTREAMS.

5. Name of your agent *(if you have one)* — Elkington and Fife

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Elkington and Fife
Prospect House
8 Pembroke Road
Sevenoaks
Kent
TN13 1XR

Patents ADP number *(if you know it)* — 67004

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of Filing *(day/month/year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of Filing *(day/month/year)*

Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.

See note (d))

N

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	1
Description	6
Claim(s)	0
Abstract	0
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	0
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this application.

Signature

Date 3 July 1998

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr Peter Finnie
0171 405 3505

Patents Form 1/77 Continued

3. Full name, address and postcode of the or of each applicant

Malcolm J Law
14 Stonecroft Close
Hangleton
Hove
East Sussex 7172737001
BN3 8BP

Robert Stuart
21 Storeys Way
Cambridge
CB3 0DP
7470479001

TRANSCODERS FOR FIXED AND VARIABLE RATE DATA STREAMS

Field of invention

The invention relates to the transmission of a recording through mastering, authoring and delivery to the consumer, where some links in the chain require transmission at a fixed data-rate, and others preferably require a variable data-rate in order to reduce the total amount of data.

Background to the invention

In reference [6] it is explained that an audio signal may be subject to a compression process (for example, lossless compression) which produces a compressed stream of varying data-rate.

In an application such as DVD, two parameters are of importance: the peak data-rate; and the total amount of data. On the DVD audio disc as currently proposed, the peak data-rate must not exceed 9.6Mbits/s as the disc cannot deliver data faster than this. On 6-channel audio recordings made to 24-bit precision and with 96kHz sampling frequency, this limit is a significant constraint, and references [1], [2] and [6] describe methods directed towards minimising the data-rate during peak passages. In addition the total amount of data on the disc is restricted to 4.7Gbytes, so it is advantageous to reduce the rata-rate below 9.6Mbits/s when possible so as to maximise the playing time.

Thus, the stream as recorded on the disc needs to be variable-rate in order to maximise the playing time.

On the other hand, many protocols for the serial transmission of data assume a fixed data-rate. Moreover, a fixed-rate stream can have a much simpler interface to a subsequent processing block. Typically the data is handled by a *transport layer* which is ignorant of its internal structure, and then passed to a decoder or other processing block. In a software implementation, a decoder will typically be called in order to decode a block of audio samples, for example 80 samples. If the input to the decoder

is a fixed rate stream, the transport layer and the software 'harness' that organises the data-flow can know the data rate and thus provide to the decoder the correct number of bits of input data to allow the decoder to produce a block of decoded samples. Whereas in the variable rate case, the required number of bits is in general not known until decoding is started, and the interface is complicated considerably by the decoder's having to request a dynamically varying number of samples from the harness.

Moreover, the need for the decoder to signal to the player how many bits are to be transferred requires two-way communication, which is extremely inconvenient if the decoder is separated from the hardware that controls the rate of replay from the disc and associated buffering, (for example, it a separate sub-unit of a player, or it is a separate item external to a player).

In general, a compressed stream will not be a homogenous stream of bits, but will be divided internally into units representing a given number of audio samples: typically 1000 or 2000 audio samples. We will refer to these units as *packets*: the IEC958 transport protocol uses the term 'burst', and compression systems such as AC-3 or MPEG use terms such as 'frame' or 'sync frame'. The packet will start with a 'packet header', which can include the data-rate (or the number of bits in the packet, which is equivalent if the number of samples represented by the packet is known). It might be thought that, given this information, the transport layer will know how many bits to send to the player at each stage, so that the need for two-way communication does not arise. However, it is in general inconvenient to require the decoder to decode a complete packet's worth of data on each call, and if the decoder decodes fewer samples than this, the question of how much data it needs for each call arises once again.

It is well understood that a variable-rate stream can be converted into a fixed-rate stream having a rate equal to the peak rate of the variable-rate stream, simple by stuffing with zeroes (or other fill-in data) during periods of less than the peak data rate. In reference [6] method is described whereby the data rate of the fixed rate stream can be somewhat less than the peak rate of the variable rate stream. This is achieved by

using a FIFO buffer in the decoder so that the 'core decoder' can be supplied with data at a higher rate than that from the input stream, for short periods. The amount by which the data rate is less than the peak of the variable rate steam depends on the size of the FIFO buffer and the nature of the signal.

It is a significant disadvantage that both the minimum rate of a fixed rate representation of a signal, and the total amount of data contained in a variable rate representation of the signal, are not known until the signal has been encoded in its entirely.

Summary of invention

According to the invention in a first aspect, a variable rate stream of encoded data is derived from a fixed-rate packetised stream by deleting the 'stuffing' in the fixed-rate stream or replacing it by a suitable code that will indicate to a decoder the amount of stuffing that has been removed. In a preferred embodiment, the variable rate stream has packet headers which indicate the data-rate of the fixed rate from which the variable-rate stream was derived.

Using this strategy, an encoder which encodes according to the methods in reference [6] can use a single strategy for assessing under-run or over-run in the decoder's buffer, independently of whether fixed-rate or variable-rate packetisation is used.

According to the invention in a second aspect, a decoder for a variable rate stream produced by the invention in its first aspect, may be derived from a decoder for the corresponding fixed rate stream, by modifying the input stages of the decoder such that the input is stalled during the periods when the corresponding fixed-rate decoder would be reading the stuffing.

In this case the data-rate consumed by the variable-rate decoder is either the data-rate consumed by the fixed-rate decoder, or zero.

An extension of the invention in its second aspect is a decoder for both fixed rate and variable rate streams, whereby the stuffing is either expected in the stream, or inferred.

The invention in its second aspect also provides a unified interface to the transport layer, whereby fixed-rate decoding is a special case of variable rate decoding in which the input is never stalled.

According to the invention in a third aspect, a transcoder converts a variable rate packetised stream having a constrained peak data rate declared in the packet headers to a fixed rate stream of the same rate as the declared peak rate of the variable rate stream.

According to the invention in a fourth aspect, a DVD player incorporates a transcoder where by a variable rate stream on the disc is converted to a fixed rate, or alternatively a fixed rate stream on the disc to a stream of a higher fixed rate, in order to drive a external equipment through an interface operating at the said fixed rate or higher fixed rate.

According to the invention in a fifth aspect, a DVD player incorporates a transcoder where by a variable rate stream on the disc is converted to a fixed rate, or alternatively a fixed rate stream on the disc to a stream of a higher fixed rate, in order to drive an internal decoder through an interface operating at a convenient fixed rate. The transcoder is a 'lightweight' process which can preferably be incorporated into the custom silicon used to retrieve the data bits from the disc. The transcoder can also be tightly integrated with the buffering incorporated in the player, in order that the variable rate data can be optimally handled.

According to the invention in a sixth aspect, a mastering system performs lossless encoding of the output audio stream, and notes the total amount of encoded data and/or the minimum fixed rate to which the data can be packetised, on the assumption of a given amount of FIFO buffer memory in a decoder. (Alternatively the encoder may note the rate for each of several different assumptions about the decoding specification.)

The mastering system can deliver the output stream in any of several formats, for example linear PCM, a variable-rate losslessly compressed stream, or a fixed-rate losslessly compressed stream. In the case of a fixed-rate stream, the rate will be set

generously high, as the data rate and the total amount of data are not critical at this stage.

The notes of the total amount of data and/or the minimum rate or rates to which fixed-rate packetisation is possible are then retained with the output stream, preferably by recording them at the start of the output file. This avoids the requirement for a subsequent mastering stage to perform a pre-scan of the data in order to determine the minimum rate for subsequent transmission. The minimum rate at which fixed-rate packetisation is possible can also be used as an upper bound of the data rate of a variable-rate stream derived from the fixed rate stream in the manner of the first embodiment of the invention.

The note of the total amount of data is also of use to a mastering engineer in estimating the available playing time on a disc composed of several tracks.

Brief Description of the Drawings

Figure 1 incorporates several aspects of the present invention, and shows a mastering system according to the sixth aspect, followed by an authoring system which derives a variable-rate stream for use on DVD, using the note' of the peak data rate as described above. The DVD player has the option to decode to PCM audio, or to output the compressed stream at a fixed rate in accordance with the fourth aspect of the invention. "MLP" is a proprietary format for a compressed audio data stream, which has the fixed and variable-rate embodiments.

References

[1] P.G. Craven & M.A. Gerzon, 'Lossless Coding for Audio Discs', *J. Audio Eng. Soc.*, vol. 44 no. 9 pp. 706–720 (September 1996)

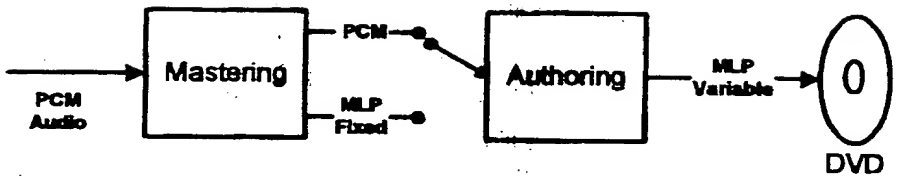
[2] P.G. Craven, M.J. Law & J.R. Stuart, 'Lossless Compression using IIR Prediction Filters', *J. Audio Eng. Soc.* (Abstracts), vol. 45 no. 5 p. 404 (22nd March 1997) (Preprint #4415)

[3] P.G. Craven & J.R. Stuart, 'Cascadable Lossy Data Compression Using a Lossless Kernel', *J. Audio Eng. Soc.* (Abstracts), vol. 45 no. 5 p. 404 (22nd March 1997) (Preprint #4416)

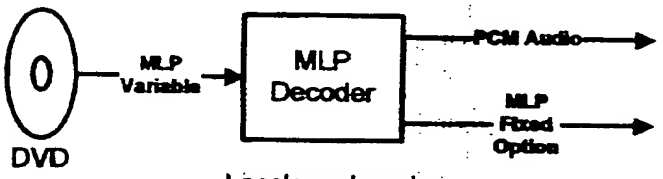
[4] M. Bosi *et. al.*, 'ISO/IEC MPEG-2 Advanced Audio Coding', *J. Audio Eng. Soc.* vol. 45 no. 10 pp. 789–814 (October 1997)

[5] 'Lossless Coding Method for Waveform Data', *International patent application* no. PCT/GB96/01164

[6] 'Data rate control for Variable Rate compression systems' US patent application filed 20th March 1998; inventors Peter Graham Craven and Malcolm James Law



Lossless encoder at mastering or authoring



Lossless decoder

Fig. 1